1876

Illustrations of the treatment of nickeliferous ores at Mine La Motte, Madison County, Missouri

William C. Minger

THESIS

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NICKELIFEROUS ORES

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MISSOURI SCHOOL OF MINES AND METALLURGY.

ILLUSTRATIONS

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AT

MINE LA MOTTE.

Madison County,

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A THESIS

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Nickeliferous Ores.
Mine la Motte, Madison County, Mo.

Historical and Descriptive.

The Mine la Motte property con=
=sists of a tract of about 24000 acres sit=
=uated in the counties of Madison and St.
Francois, principally in the former, however.
It has been worked since the year 1720, and
besides its historical interest is certainly
one of the most important mines in the state,
as regards both the capitalist and scientist.
These facts warrant a detailed description of
the mines, and the methods of working which are
in vogue there, these being necessary to any one
who would realize their magnitude and importance.
The property is situated about 100 miles South=
=east of St. Louis on the Iron Mountain Rail=
=road. The principal mining is done at the village
of Mine la Motte, three miles east of Mine
la Motte station. The deposits of Nickel and
Cobalt found here are the most extensive
now known and operated in the United States,
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The Diggings.

The chief points at which the mining is carried on

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are at the "Bluff Diggings", the "Jack Diggings", and the "Seed-tick Diggings". The "Bluff" and "Jack" Diggings are about one mile apart, and are separated by a ridge running South east, and North west. At the "Jack Diggings" more than five acres of rock have been excavated, the mining being mostly confined to one immense chamber, the vault being supported by stone columns, either left when mining or built up afterward of the refuse material.

Mining.

The mining is done in the ordinary way, proper to horizontal bedded deposits. About 170 miners are kept continually at work removing the ore.

Analyses of specimens of the crude ore gave the following results:

Specimen of raw ore from Seed Tick Diggings:

Copper,	13.319%
Zinc,	0.020"
Nickel,	0.233"
Iron,	13.517"
Total foreign metals	27.089"

This particular specimen was somewhat remarkable for the large amount of copper and Iron it contained.

A specimen of raw ore from the "Bluff Diggings" gave the following result:

Zinc,	0.040%
Nickel,	0.214"
Iron,	2.529"
Total foreign metals,	2.783"

Washing and Dressing the Ore.

The ores are transported form the mines to the dressing-works in small cars running on tramways, and capable of carrying from 4000 to 10000 pounds of ore. Crushing: The ore is crushed, first in a Blake's Breaker capable of crushing from 25 to 30 cars per day of 24 hours or an average of about 175000 lbs. The crushed ore is now passed through rollers and then through circular sieves, the coarser particles from which pass into the elevator, and again through rollers now set more closely together, and this is repeated untill all passes through the sieve. The sieved ore now passes into the Jigs which wash off the light particles, and divides the ore into two classes: "Smiddam" or coarser, and Sludge or finer. The following are the results obtained upon analysis of specimens of the two grades of washed ore:

Smiddam (coarse)	
Copper	0.103%
Cobalt	0.042"
Nickel	0.575"
Iron	1.435"
Total	2.155"

Sludge (fine)

Copper	0.080%
Cobalt	0.357"
Nickel	0.168"
Iron	1.953"
	2.558"

The washed and dressed ore is now treated, part in the cupolas, and the rest in the Scotch hearth furnaces.

Scotch Hearth treatment.

Dimensions of the furnace:

Area of Base — 22×24 inches. Length of shift 8 hours

Height of hearth — 15 inches.

Number of tuyres — 3

Diameter of nozzle — 1⅛ inches.

Pressure of blast — 4 ounces of mercury.

Operations.

A part of the washed and dressed ore is treated in the Scotch Hearth for 8 hours, and the products are, a work lead and a residue. This residue contains nearly all the Nickel and Cobalt contained in the ore treated in the Scotch hearth, and is composed of a mixture of Slaggy matters, and Sulphide of Lead, mixed with a small proportion of other constituents. The result of an analysis of a

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specimen of this residue is given below:

Empirical Composition:

SiO_2	17.465%
Al_2O_3	4.349 "
CaO	10.309 "
MgO	3.413 "
BaO	0.469 "
Co	0.438 "
Ni	0.852 "
Zn	0.327 "
Fe	4.114 "
Pb	45.977 "
S	7.341 "
O	2.049 "
SO_3	2.863 "
Total	99.966 "

Rational Composition:

SiO_2	17.465%
Al_2O_3	4.349"
CaO	9.242"
MgO	3.413"
Fe_2O_3	5.877"
$CaOSO_3$	2.580"
$BaOSO_3$	0.714"
$PbOSO_3$	4.173"
CoS	0.675"
NiS	1.242"
ZnS	0.488"
PbS	48.758"
PbO	0.990"
Total	99.966%

This residue is now passed to treatment in the cupola with a part of the previously roasted ore.

The Cupola furnaces.

Dimensions of the circular cupola:

Diameter of furnace, 3 feet.

Height of charging place above tuyres – 12 feet.

" " tuyres above hearth plate – 8 inches.

Thickness of the lining 21 inches.

A shift lasts 12 hours and requires 5 men to the shift.

Dimensions of the square cupola:

Thickness of wall 2.5 feet.

Height of tuyres above hearth-plate – 11 inches

" " furnace above tuyres – 11 feet.

No. of tuyres – 3: diameter of nozzle – 2 5/8 inches

Pressure of blast, about 10 oz of mercury.

The method of treating the ore is the same in both cupolas and consists in charging the pulverized and roasted ore, coke and flux in alternate layers. The flux used is a hematite obtained from Iron Mountain. Its composition is as under:

Ferric oxide	= 94.545%
Alumina	— 3.922"
Magnesia	— 0.401"
Lime	— 0.129"
Silica	— 1.182"
Total	— — 100.179.

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Total	100.179

The products obtained from the first treatment of the ore in the cupola are, Slag, a lead, and matte. The Slag is thrown away. Upon analysis it was found to give:

Empirical	Composition.
SiO_2	53.435%
Al_2O_3	53.435"
CaO	15.046"
MgO	8.633"
[Co + Ni]	0.514"
Zn	0.291"
KO	0.708"
Fe	11.328"
S	3.441"
O	0.219"
Total	99.834%

Rational	Composition.
SiO_2	53.435%
Al_2O_3	6.219"
CaO	15.046"
MgO	8.633"
$(Co + Ni)S$	0.793"
ZnS	0.436"
Fe_2S	13.576"
KO	0.708"
FeO	0.988"
Total	99.834%

From which it will be seen that this slag is nearly a bisilicate mixed with small percent of sulphides.

The matte obtained above is technically called the

First Matte.

Its composition is as follows:

Empirically:	
SiO_2	20.827%
Al_2O_3	8.434”
CaO	7.867”
MgO	3.442”
Cu	0.192”
Zn	0.139”
Co	1.195”
Ni	2.486”
Pb	5.762”
Fe	36.345”
S	10.418”
O	2.971”
Total	100.078”

Rationally:	
SiO_2	20.827%
Al_2O_3	8.434”
CaO	7.867”
MgO	3.442”
Cu_2S	0.241”
ZnS	0.208”
CoS	1.843”
NiS	3.828”
PbS	6.659”
Fe_2S	33.359”
FeO	13.370”
	100.078”

This matte is now roasted in heaps and is called then, a "roasted matte."
Its composition is as follows:

	Empirical:
SiO_2	7.804%
Al_2O_3	2.221"
CaO	2.241"
Ni	3.721"
Co	2.203"
Cu	1.523"
S	9.921"
O	9.796"
SO_3	3.979"
Fe	56.591"
	100.000%

Or, admitting the existence and possible presence of a hemisulphide of Iron, as it has been found to exist in mattes*;

	Rational:
SiO_2	7.804%
Al_2O_3	2.221"
Fe_2O_3	39.877"
$CaOSO_3$	5.442"
$FeOSO_3$	1.338"
$NiOSO_3$	0.186"
NiS	5.631"
CoS	3.398"
Cu_2S	1.908"
Fe_2S	31.044"
Fe_4S	1.154"
Total	100.000%

*Watts Dictionary of Chemistry, Vol. III, page 400.

The roasted Matte is again treated in the Cu=
=pola and the result is "The Concentrated Matte".

Its Composition is as follows:

Empirical:		Rational:	
SiO_2	1.436%	SiO_2	1.436%
Al_2O_3	2.659"	Al_2O_3	2.659"
CaO	4.653"	CaO	4.653"
MgO	0.776"	MgO	0.776"
Ni	5.685"	FeO	7.920"
Co	2.005"	NiS	8.769"
Cu	0.608"	CoS	3.092"
Zn	0.282"	Cu_2S	0.762"
Fe	63.819"	ZuS	0.421"
S	16.317"	Fe_4S	36.676"
O	1.760"	Fe_2S	32.536"
	100.000%		100.000%.

This matte is that from which the Nickel and Cobalt is manufactured directly from and is now barrelled and shipped to Europe.

Yield of Matte and Pig Lead:

During the week ending Nov. 20/75 18000 lbs First Matte were produced
" " " " " 27 " 10000 " " " " "
" " " " Dec 4 " 8000 " " " " "
" " " " " 11 " 3000 " " " " "
" " " " " 18 " 16000 " " " " "
" " " " " 25 " 15000 " " " " "

6 | 70000

11666 " " " per week.

During the same time (6 weeks) the ore used was 1174997 pounds and the Pig lead produced was 736560 pounds. So that the Results of 6 weeks work of the furnaces stands thus:

Ore used pounds = 1,174,997
Lead produced " = 736,560
First Matte " " = 70,000 = 2576.7 lbs Ni + Co.